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Notes on the systematics of the *maenas*-group of the genus *Actias* LEACH 1815 (Lepidoptera: Saturniidae)[1],[2]

by

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Abstract: A preliminary review of the species-group of *Actias maenas* DOUBLEDAY 1847 is given, with list of synonyms. Four species are recognized: *Actias maenas* DOUBLEDAY 1847 with two subspecies (*A. m. maenas* from continental Asia and *A. m. diana* MAASSEN [1872] **stat. nov.** from Sundaland and possibly the Philippines), *A. ignescens* MOORE 1877 **stat. nov.** from the Andamans, *A. isis* (SONTHONNAX [1897]) from Sulawesi, and *A. groenendaeli* ROEPKE 1954 from Flores, Timor, and Sumba. A fifth species of doubtful status (possibly based on mislabeled specimens) is cited: *Actias rosenbergii* (KAUP 1895) from Ambon. Hypotheses on the relationships within the group are presented.

Anmerkungen über die Systematik der *maenas*-Gruppe der Gattung *Actias* LEACH 1815 (Lepidoptera, Saturniidae)

Zusammenfassung: Es wird ein vorläufiger Überblick über die Artengruppe um *Actias maenas* DOUBLEDAY 1847 zusammen mit einer kurzen Synonymieliste gegeben. Vier Arten werden anerkannt: *Actias maenas*

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(1) = 30th contribution to the knowledge of the Saturniidae.

(2) = This article was originally planned as the taxonomic introduction of a paper on the subspecies of *Actias groenendaeli,* written by the author in coauthorship with Yasunori KISHIDA, Tokyo, Japan. At the time we began to write that manuscript (1991), we originally intended to describe a new subspecies of *A. groenendaeli* from the island of Timor. But then more specimens both from Flores and Timor were collected by U. and L. H. PAUKSTADT, and after studying the larger series we eventually decided not to describe a new taxon, because the variability was bigger than originally expected, and the two populations did not seem to be reliably distinct any longer. So we canceled our plan. Nevertheless, those paragraphs on the systematics of the whole group compiled by me during the preparation of the mutual manuscript still seem to be interesting and are based on an extensive literature research; so it is my intention to publish these parts separately now, slightly revised, to make the results available.

Nachr. entomol. Ver. Apollo, Frankfurt/Main, N.F. **15** (3): 327–338, November 1994; ISSN 0723-9912.

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DOUBLEDAY 1847 mit zwei Subspezies (*A. m. maenas* vom asiatischen Kontinent und *A. m. diana* MAASSEN [1872] **stat. nov.** von Sundaland und möglicherweise den Philippinen), *A. ignescens* MOORE 1877 **stat. nov.** von den Andamanen, *A. isis* (SONTHONNAX [1897]) von Sulawesi und *A. groenendaeli* ROEPKE 1954 von Flores, Timor und Sumba. Eine fünfte Art von zweifelhaftem Status (wahrscheinlich auf fehletikettierten Stücken basierend) wird aufgeführt: *Actias rosenbergii* (KAUP 1895) von Ambon. Hypothesen über die Verwandtschaftsbeziehungen in der Gruppe werden vorgestellt.

Introduction

The so-called "moon moths" of the genus *Actias* LEACH 1815 (*sensu lato*) are famous among collectors and have been well-known for nearly two centuries. Recent collecting in Indonesia on the Lesser Sunda Islands resulted in interesting new information on *Actias* from there (PAUKSTADT & PAUKSTADT 1992, 1993). During studies on *Actias* moths of the species-group of *A. maenas* DOUBLEDAY 1847, several questions on taxonomy and some identification problems arose from earlier literature. Therefore, remarks on the systematics of the species-group are published here. In addition, some ideas on the phylogeny of this species-group are presented.

Systematics

Many names within the genus *Actias* s.l. used by authors of the 19th and early 20th century for decades were poorly defined, used for different species, and often used in correspondence only without formal publication and description (examples: *diana* or *isis*), resulting in several confusing *nomina nuda*. Type-localities and distributional information were only given unreliably, if at all. Many of the authors interpreted several or all of the taxa to be conspecific, and the names used in correspondence were thus often chosen as a matter of personal preference, irrespective of priority considerations. Compilation literature (like the Lepidopterorum Catalogus [SCHÜSSLER 1936], the museum catalogue of The Natural History Museum, London [formerly British Museum (Natural History), BMNH], or SEITZ 1926) often cited wrong authors and dates for the original publication of a taxon. For a systematic revision of the group it will be necessary to survey the old literature to verify correct dates and authors and original combinations of the different taxa. The names and dates given here were verified in all

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cases in the cited publications, but future changes due to the discovery of older publications cannot be excluded.

The genus *Actias* has often been split excessively (e.g., ARORA & GUPTA 1979). Recent workers have, however, agreed that this does not make much sense, and used only one or two generic names (*Actias* and *Argema* WALLENGREN 1858) on basis of phylogenetic reasoning (e.g., NÄSSIG & PEIGLER 1984, HOLLOWAY 1987, NÄSSIG 1991; NÄSSIG, PEIGLER, FIEDLER, in prep.) for the species of the group known from Europe, North America, Asia, and Africa.

The following four species plus one doubtful taxon are known in the species-group of *Actias maenas:*

1. *Actias maenas* DOUBLEDAY 1847

(*Actias maenas* DOUBLEDAY: Ann. Mag. Nat. Hist. **19:** 95, pl. 7)
Type locality (TL): Silhet, [Bangladesh].

Subspecies recognized:

a) *Actias maenas maenas* DOUBLEDAY 1847

Synonym:
Saturnia leto DOUBLEDAY 1848 (Trans. entomol. Soc. Lond. **5,** Proceedings: LI) (TL: "India Orientalis" [= Silhet, Bangladesh])

b) *Actias maenas diana* MAASSEN [1872], **stat. nov.**

(*Actias diana* MAASSEN: "Beiträge zur Schmetterlingskunde", **2:** fig. 12) (TL: Java)
Synonyms:
Sonthonnaxia saja VAN EECKE 1913 (Notes Leyden Mus. **35:** 134) (TL: Sumatra/Java [lectotype not yet designated, syntypes in Leiden])
Sonthonnaxia recta BOUVIER 1928 (Bull. Hill Mus. **2:** 138) (TL: Sumatra)

Nomenclatural note: *Actias diana* MAASSEN [1872] is here considered not to be a secondary junior homonym of the following taxa:

Plectropteron dianae HUTTON 1846 [Ann. Mag. Nat. Hist. **17:** 60 – a synonym of *Actias selene* (HÜBNER 1806) –, which is a nomen nudum and therefore unavailable, moreover differing in one letter (Art. 57(f) of ICZN)], and

Saturnia diana FAIRMAIRE 1849 [Ann. Soc. entomol. France **(2) VII:** LXII, which is a nomen nudum and therefore unavailable, see NÄSSIG (1991)], and

Saturnia diana GRAELLS 1849 [Rev. Mag. Zool. **(2) 1:** 602, which is also a nomen nudum and therefore unavailable].

If MAASSEN's name were to be considered a secondary homonym, the next available name for the Sundanian populations would be *saja* VAN EECKE.

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The life-history of *Actias maenas diana* from Java, West Malaysia and Sumatra was described by, e.g., TOXOPEUS (1948), LAMPE (1983) and NÄSSIG & PEIGLER (1984).

Distribution:
A. maenas maenas: N. India (HAMPSON 1892, ARORA & GUPTA 1979), Nepal (ALLEN 1993), Bangladesh, SW China (Yunnan) (ZHU & WANG 1983), northern Thailand (PINRATANA & LAMPE 1990), Vietnam (Tonkin) (TESTOUT 1945).
A. maenas diana: Sundaland (Peninsular Malaysia: LAMPE 1984, 1985; Borneo: HOLLOWAY 1987; Java & Sumatra: VAN EECKE 1913); possibly also on the Philippines (SCHULTZE 1925; leg. TREADAWAY, SETTELE, CERNY & SCHINTLMEISTER, specimens in colls. W. A. NÄSSIG & C. G. TREADAWAY)
The borderline separating the northern from the Sundanian subspecies seems to be in South Thailand; specimens from Ranong in South Thailand (just south of the Isthmus of Kra) are already *A. m. diana* according to their wing pattern (S. NAUMANN, Berlin, pers. comm.), while specimens from near Bangkok and further north still are the nominotypical subspecies.

Note: There are some constant (though minor) differences in genital morphology, wing shape, wing pattern, colour, and size between N. Indian and Sundanian specimens which apparently make it necessary to distinguish these populations as separate, although weakly defined, subspecies. – The status of the Philippine populations requires further research; their inclusion under ssp. *diana* is preliminary, a study is in preparation.

The wrong interpretation of the taxon *leto* DOUBLEDAY, which was listed with the incorrect type locality "Java" in most publications (e.g., SCHÜSSLER 1936, HOLLOWAY 1987) instead of Bangladesh, possibly originated from a misinterpretation of MAASSEN's (1869) text; MAASSEN wrote "Java" for his specimen which he named *"Leto"*. Only VAN EECKE (1913) and TESTOUT (1944, 1945) interpreted the type localities correctly, but these lines were overlooked by most subsequent authors.

2. *Actias ignescens* MOORE 1877, stat. nov.

(*Actias maenas ignescens* MOORE: Proc. zool. Soc. Lond. **1877:** 602)
TL: S. Andamans

Two male syntypes in BMNH, examined.

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Distribution: India: Andaman Islands

Note: Although the differences in genital morphology between the continental *Actias maenas* and the Andaman *A. ignescens* are only minor, it seems preferable to treat the long-isolated Andaman population as a distinct species. PEIGLER (1989: 75) acted similar when elevating the Andaman taxon *macmulleni* WATSON 1914 to a full species in the genus *Attacus* LINNAEUS 1767. The colouration of *A. ignescens* is (as far as can be seen from the two battered specimens known to me of that species) distinct from that of *maenas* and to some degree similar to that of the following species, being largely brownish. But *A. maenas* and *A. ignescens* share the very elongate shape of aedeagus and saccus in male genitalia, which is, by comparison with *Actias* species outside the *maenas*-group, an apomorphic character. *A. ignescens* is somehow more round-winged than *A. maenas*.

3. *Actias isis* (SONTHONNAX [1897])

(*Argema isis* SONTHONNAX: Essai classif. Lep. Prod. Soie 1899 [1897] **2:** 14) TL: Minahassa, N. Sulawesi (Celebes) (according to the label of the holotype in Berlin, examined).

Nomenclatural note: The name *Saturnia isis* WESTWOOD 1849 [Proc. Zool. Soc. London **17:** 47] was not accompanied by a description or illustration and is therefore a *nomen nudum*. Its locality was given as "Java" by WESTWOOD. Moreover, it is a primary homonym of *Saturnia isis* WESTWOOD [1845] [in: JARDINE, W., The Naturalist's Library, Entomology, vol. **32:** 138, pl. 13], which was given for an African species never belonging to the genus *Actias*.

Synonyms:
Argema latona ROTHSCHILD & JORDAN 1901 (Novit. zool. **8:** 404) (TL: N. Sulawesi) (Syntypes in BMNH, examined)
Sonthonnaxia ignescens f. *cotei* TESTOUT 1945 [infrasubspecific, described as "form[e] ind[ividuelle]"] (N. Sulawesi) (Bull. Soc. Linn. Lyon **13:** 147, fig. 8 [ill.]; **14:** 10 [text])

Distribution: Indonesia: Sulawesi (and probably smaller islands adjacent to Sulawesi).

Note: *A. isis* is a full species clearly distinct from the above two species (see also PAUKSTADT & PAUKSTADT 1991); it has, as well as *A. groenendaeli,* a much shorter aedeagus and saccus, which is the plesiomorphic situation in the group. *A. isis* is very similar to true *A. maenas* in size and wing shape and seems to be an intermediate between the plesiomorphic eastern species *A. groenendaeli* and the advanced western *A. maenas* and *A. ignescens*. The extension of the

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brownish or reddish-brownish darkening of the wing colouration is variable (up to nearly uniformly brown); some male specimens may be fairly yellowish and resemble to some degree dark specimens of *A. maenas,* although the male genitalia are always typical for *A. isis*. (Material from old collections may often be mislabeled! I found a typical Sundanian *maenas* male with a "Celebes" label, which surely was not collected on that island; before World War II, some traders and private collectors obviously were often as unreliable with their labeling as they still seem to be today in some cases.) The females are darker yellowish, with some differences in the wing pattern (see VAN EECKE 1913), but generally quite similar to those of *A. maenas*.

VAN EECKE's (1913) and TESTOUT's (1945) distinction between two "subspecies" *isis* and *latona* (both described from northern Celebes!) is not justifiable and nonsensical. The variability of Sulawesian specimens may perhaps be correlated with rainfall and humidity and thus be some kind of seasonality.

I have examined the male holotype of *A. isis* in coll. STAUDINGER in Naturhistorisches Museum der Humboldt-Universität, Berlin, Germany. SONTHONNAX (1899 [1897]) validated a formerly unpublished *"in litteris"* name of MAASSEN (and other workers, see above). If the taxon *isis* SONTHONNAX were to be recognized as a homonym, the name *latona* ROTHSCH. & JORD. would be the next available one.

4. *Actias groenendaeli* ROEPKE 1954

(*Actias maenas groenendaeli* ROEPKE: Tijdschr. Entomol. **97:** 257)
TL: Flores

Distribution: Indonesia: Flores, Timor; also recently discovered on Sumba according to KISHIDA (*in litt.* 1993).

Note: *A. groenendaeli* was described by ROEPKE (1954) as a subspecies of *A. maenas*. The holotype of the taxon consists only of the damaged wings of a female specimen without body. This holotype is deposited in the Nationaal Natuurhistorisch Museum (NNML; formerly Rijksmuseum van Natuurlijke Historie) in Leiden, Netherlands (examined). As the females of species of the *maenas*-group of *Actias* are always much more similar to each other than the males, ROEPKE's idea of conspecifity can easily be understood.

There are some minor differences, merely tendencies, between the moths from Timor and Flores. But the individual variability of the species is comparatively large, and after having seen larger series of

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both populations (in coll. PAUKSTADT and in NNML) there seems not to be any reason for separating these populations taxonomically. No reliable genitalia differences were found; as usual, there is of course some minor individual variability in male genitalia as well (females have not been dissected by me thus far).

The formerly unknown male of *Actias groenendaeli* from Flores was recently described and illustrated by PAUKSTADT & PAUKSTADT (1992). These authors also published for the first time that *A. groenendaeli* is a distinct species and not a subspecies of *A. maenas*. Details may be taken from these authors. The preimaginal morphology was published by PAUKSTADT & PAUKSTADT (1993).

5. *Actias rosenbergii* (KAUP 1895) [doubtful species]

(*Tropaea rosenbergii* KAUP, J. J.: *"Tropaea rosenbergii* aus der Familie Saturnidae" [sic], Darmstadt & Leipzig (E. Zernin), 1895, 3 pp. + 1 pl.)
TL: "Ambon"

Possible synonym:
Argema rieli TESTOUT 1942 (Bull. Soc. Linn. Lyon **11:** 89) (TL: "Ambon")
Holotype in Paris (TERRAL, pers. comm.)

Distribution: "Indonesia: Ambon" (doubtful)

Note: SEITZ (1926) wrote that KAUP's description was already printed in 1866 in a book by PLÖTZ, "Exot. Schmett., Saturn., Fig. 33 d". I have not found this book in German libraries (including Darmstadt) and catalogues, and a research in the Library of The Natural History Museum, London (BMNH), by Ms Pamela GILBERT did not result in any reconfirmation of that earlier publication (except a handwritten remark on the BMNH copy of the 1895 publication). Therefore I take 1895 as publication date. Probably PLÖTZ's publication of 1866 was only a private circular and not really published.

The type specimen of *rosenbergii,* which was said by SEITZ (1926) to be preserved (but already damaged and bleached) in Hessisches Landesmuseum Darmstadt, Germany, no longer exists there (Dr. FEUSTEL, curator of Hessisches Landesmuseum in Darmstadt, *in litt.* 1988); most likely it has been destroyed during World War II air attacks. The type specimen of TESTOUT's *Argema rieli* is not in Lyon (C. LEMAIRE, *in litt.*) as expected, but has recently been discovered in Paris (G. TERRAL, *in litt.*). No further museum material from Ambon or Seram (Ceram) is known to me.

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TESTOUT (1942) speculated about the correct identity of KAUP's female; he expressed the opinion that KAUP's specimen was a "typical *maenas*" female. I agree with this opinion. The illustration of KAUP shows a specimen with broad bands (i.e., impressions of the setting papers, not natural wing pattern!) on all wings, which may possibly be a mislabeled true *A. maenas* female. The missing hindwing ocelli are either lost by rubbing (KAUP's own interpretation) or are some kind of individual aberration and surely irrelevant for taxonomy.

The photograph of the male genitalia of *A. rieli* in TESTOUT (1942) clearly shows, although damaged, a long saccus (the aedeagus is evidently missing), which is known only from western *Actias maenas* and *A. ignescens,* but not from the eastern taxa. The type specimen itself (photographed by G. TERRAL in Paris) is a large, bright yellowish-green male with the typical wing pattern of *maenas,* with long tails and falcate forewings, all characters typical for Sundanian specimens.

Recent collecting expeditions on Seram and Ambon (by workers of the C.A.B. International Institute of Entomology/Dr Jeremy D. HOLLOWAY and the BMNH and by A. SCHINTLMEISTER) never resulted in any member of *Actias* being collected. It seems therefore advisable for the present to treat *A. rosenbergii* as a dubious species, possibly based on mislabeled specimens. Although ROSENBERG, the collector of the specimen described by KAUP, really did collect on Ambon (Amboina), the specimen may have originated from another Indonesian island on the Sunda Shelf or from the Philippines. As long as no new specimens are reliably collected to confirm the existence of an *Actias* species from Ambon, Seram, and/or Buru, I think that there is probably no endemic member of the *maenas*-group living on these islands. If more intensive collecting would result in specimens from Ambon or Seram, it might be necessary to designate an adequate neotype for the taxon *rosenbergii* to fix the correct identity of the taxon. I expect that TESTOUT's taxon *rieli* will eventually be synonymized with *A. maenas diana* (as a result of genitalia and external morphology), but have not yet examined the type specimen personally.

It cannot be ruled out at present, however, that a population of *Actias maenas* of, e.g., Sundanian origin may have been introduced by man into islands of Eastern Indonesia and then lived there for some time or permanently. Similar evidently unnatural disjunctions are known for *Attacus atlas* (compare PEIGLER 1989). In that case, a name would be totally unnecessary for a population caused by an anthropogenous act.

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Phylogenetic ideas

The key-question about the phylogenetic relationships within *Actias sensu lato* is probably the relationship between the African species and all other. The question is whether the genus *Argema* WALLENGREN 1858 (ca. three species in tropical continental Africa plus one in Madagascar) is the sister-group to all Asian, European, and American *Actias* species (in which case the genus *Argema* should better be retained), or whether it is the sister-group to the *maenas*-group only, in which case the genus *Argema* should be synonymized with *Actias* LEACH 1815. Based on general morphology and on the existence of "intermediates" between the long-tailed *maenas*-group and the short-tailed *selene*-group, the first alternative seems more likely. More research is necessary.

The *maenas*-group of species is an evidently monophyletic group of 4 (or 5) closely related, allopatric species in tropical South-East Asia. Synapomorphies of these species are to be found in the following characters: many details of the wing pattern, great overall similarity in male genitalia (structures of uncus, valves, etc.), and similarity of the known larvae (2 of the species).

Genitalia morphology of males and the development of the forewing ocellus suggest that continental species like *Actias dubernardi, A. sinensis, A. rhodopneuma,* etc., are the most likely candidates for being the adelphotaxon of the *maenas*-group (the relationships are not yet fully resolved). Comparison with *Actias* species outside of the *maenas*-group clearly shows that the very elongate aedeagus and saccus in *Actias maenas* and *A. ignescens* is the apomorphic condition; in other species they are much shorter. Therefore the western species are considered further developed and evolutionarily younger. Distribution patterns suggest that after an early separation between the Asian continent (= species like *A. dubernardi, A. rhodopneuma, A. sinensis,* etc.) and the SE Asian islands (= *maenas*-group) there was a development centre of the *maenas*-group on the SE Asian islands (probably on Sundaland and/or Sulawesi), followed by a secondary re-invasion of the continent by one species only (= *A. maenas*).

Acknowledgements: The author gratefully acknowledges the cooperation with Yasunori KISHIDA (Tokyo). Assistance and support (with material, photographs, literature, and/or advice) has been contributed generously by Dr J.-M. CADIOU (Bruxelles, Belgium), Dr FEUSTEL (Hessisches Landesmuseum Darmstadt, Darmstadt, Germany), Ms Pamela GILBERT (The Natural History Museum, Library, London, UK), Dr Jeremy D. HOLLOWAY (C.A.B. Inter-

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national Institute of Entomology, c/o The Natural History Museum, London, UK), Dr Rienk DE JONG (Nationaal Natuurhistorisch Museum, Leiden, The Netherlands), Dr Claude LEMAIRE (Gordes, France), Dr Wolfram MEY (Naturhistorisches Museum der Humboldt-Universität, Berlin, Germany), Ulrich and Laela H. PAUKSTADT (Wilhelmshaven, Germany), Dr Richard S. PEIGLER (Denver Museum of Natural History, Denver, Colorado, USA), and Gilles TERRAL (Rosny, France).

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